



## Modular Rake of Pitot Probes

Individual probes can be replaced more easily than was possible before.

*John H. Glenn Research Center, Cleveland, Ohio*

The figure presents selected views of a modular rake of 17 pitot probes for measuring both transient and steady-state pressures in a supersonic wind tunnel. In addition to pitot tubes visible in the figure, the probe modules contain (1) high-frequency dynamic-pressure transducers connected through wires to remote monitoring circuitry and (2) flow passages that lead to tubes that, in turn, lead to remote steady-state pressure transducers.

Prior pitot-probe rakes were fabricated as unitary structures, into which the individual pitot probes were brazed. Repair or replacement of individual probes was difficult, costly, and time-consuming because (1) it was necessary to remove entire rakes in order to unbraz individual malfunctioning probes and (2) the heat of unbrazing a

failed probe and of brazing a new probe in place could damage adjacent probes. In contrast, the modules in the present probe are designed to be relatively quickly and easily replaceable with no heating and, in many cases, without need for removal of the entire rake from the wind tunnel.

To remove a malfunctioning probe, one first removes a screw-mounted V-cross-section cover that holds the probe and adjacent probes in place. Then one removes a screw-mounted cover plate to gain access to the steady-state pressure tubes and dynamic-pressure wires. Next, one disconnects the tube and wires of the affected probe. Finally, one installs a new probe in the reverse of the aforementioned sequence.

The wire connections can be made by soldering, but to facilitate removal and in-

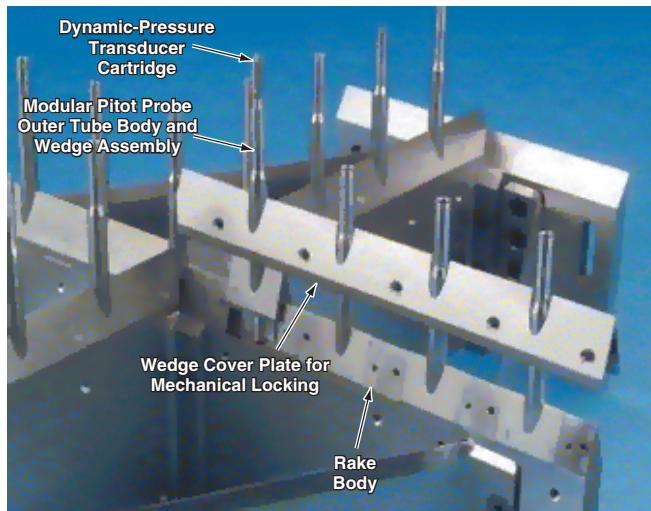
stallation, they can be made via miniature plugs and sockets. The connections between the probe flow passages and the tubes leading to the remote pressure sensors can be made by use of any of a variety of readily available flexible tubes that can be easily pulled off and slid back on for removal and installation, respectively.

*This work was done by Timothy A. Dunlap of Glenn Research Center, Michael W. Henry of QSS Group, Inc., and Raymond P. Homyk of Zin Technologies. Further information is contained in a TSP (see page 1)*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17272.*



RAKE INSTALLED IN WIND TUNNEL



ENLARGED VIEW OF PART OF RAKE WITH COVER LIFTED OFF

Each Probe Module in this probe rake is held in place by a wedge bracket under a V-cross-section cover plate. The wires and tube for connection to each probe are reached by removing one of the flat access cover plates.

## Preloading To Accelerate Slow-Crack-Growth Testing

Testing time can be reduced substantially with little effect on results.

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An accelerated-testing methodology has been developed for measuring the slow-crack-growth (SCG) behavior of brittle materials. Like the prior method-

ology, the accelerated-testing methodology involves dynamic fatigue ("constant-stress-rate") testing, in which a load or a displacement is applied to a specimen at

a constant rate. SCG parameters or life-prediction parameters needed for designing components made of the same material as that of the specimen are cal-

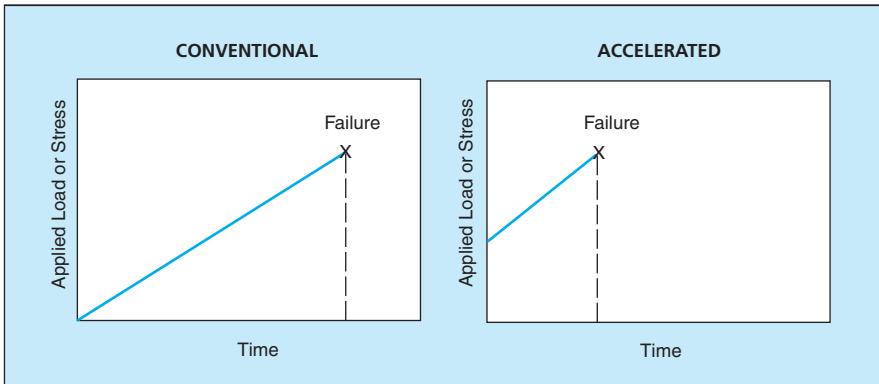


Figure 1. Applied Load or Stress is increased linearly with time in dynamic fatigue testing. In the conventional approach, one starts from zero applied stress. In accelerated testing, one starts from a preload stress that is a significant fraction of the strength of the material.

culated from the relationship between (1) the strength of the material as measured in the test and (2) the applied-stress rate used in the test. Despite its simplicity and convenience, dynamic fatigue testing as practiced heretofore has one major drawback: it is extremely time-consuming, especially at low stress rates.

The present accelerated methodology reduces the time needed to test a specimen at a given rate of applied load, stress, or displacement. Instead of starting the test from zero applied load or displacement as in the prior methodology, one preloads the specimen and increases the applied load at the specified rate (see Figure 1).

One might expect the preload to alter the results of the test and indeed it does, but fortunately, it is possible to account for the effect of the preload in interpreting the results. The accounting is done by calculating the normalized strength (defined as the strength in the presence of preload ÷ the strength in the absence of

preload) as a function of (1) the preload factor (defined as the preload stress ÷ the strength in the absence of preload) and (2) a SCG parameter, denoted  $n$ , that is used in a power-law crack-speed formulation. Figure 2 presents numerical results from this theoretical calculation.

For most glasses and advanced ceramics, the values of  $n$  are typically greater than 20. In a typical example, on the basis of the curves in Figure 2, preloading a material of  $n = 20$  at 90 percent of its non-preload strength can be expected to result in an increase of only 0.005 in the normalized strength of the material. At the same time, the 90-percent preload would make it possible to perform the dynamic fatigue test for a given rate in only one-tenth the time of a test at the same rate that starts at zero applied load. In other words, testing time would be greatly reduced, without much effect on the test results.

The theory has been verified by extensive experimentation on a variety of

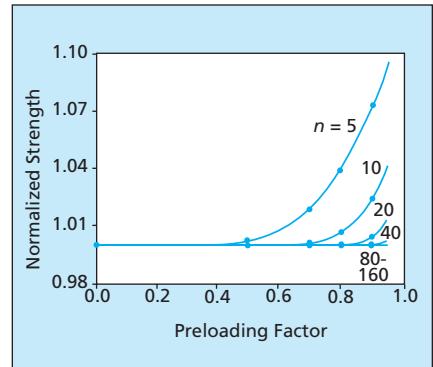


Figure 2. The Effect of Preloading on the normalized strength of a specimen as measured in a dynamic fatigue test has been computed for materials having several different values of  $n$ , a crack-growth parameter.

brittle materials, including glasses, a glass-ceramic, and various forms of alumina, silicon nitride, and silicon carbide. This accelerated-testing methodology has been adopted as the basis of two standards of the American Society for Testing and Materials for dynamic fatigue testing of advanced ceramics: C 1368 for ambient temperature and C 1465 for elevated temperatures.

*This work was done by John P. Gyekenyesi of Glenn Research Center and Sung R. Choi and Ralph J. Pawlik of Cleveland State University and Ohio Aerospace Institute. Further information is contained in a TSP (see page 1)*

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